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Water, Energy and Food (WEF) Nexus in the Changing Arctic: An International Law Review and Analysis

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Abstract: The governance of the water, energy, and food (WEF) nexus is significant in the Arctic, where environmental changes are occurring at an accelerated pace, intensifying resource dynamics and geopolitical implications. Against the backdrop of a rapidly evolving Arctic landscape shaped by the global climate change, melting ice, and resource exploration, the WEF nexus emerges as a vital framework for understanding and addressing the region's complex resource interdependencies. Nonetheless, legal research in this context is still in its early stages, and, specifically in the context of the Arctic, we did not find any such research. This study assesses a nexus approach to WEF in Arctic's transdisciplinary and multifaceted environment from an international law perspective to address the intricate dynamics that shape the resilience and security of WEF resources in an increasingly interconnected and accessible Arctic. Our objective in this study is to introduce international law as an overarching network of international rules and principles, legal instruments, and relevant institutions as a starting point to address the WEF governance intricacies in the Arctic, facilitating the harmonization of diverse interests, ensuring equitable access to resources, and promoting sustainable development. We argue that international law constitutes the essential means to address a nexus approach to WEF and its issues and complexities in a transboundary context within the Arctic. By examining existing international legal frameworks applicable to the Arctic and related instruments, policies, journals, and other publications, this paper seeks to canvas how international law is in support of a nexus approach to WEF in this region.

Keywords: international law; water, energy, and food (WEF) nexus; the Arctic; polar law; Indigenous peoples; WEF nexus governance

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1. Introduction

In this era of rapid climate change and resource scarcity, the WEF nexus has emerged as an innovative concept acknowledging the inseparable linkages among water, energy, and food systems. Historically, WEF resources have been regulated by distinct laws, regulations, and institutions in numerous countries [1]. Nonetheless, the multifaceted nature of the WEF sectors necessitates an integrated approach transcending disciplinary boundaries. In a global perspective, the WEF systems are clearly interconnected, such that irregularities in one sector could impact the other two sectors [1,2]. While energy production can lead to the pollution of water and food systems, food and agricultural practices can also cause water contamination and energy wastage [1,3].

At the heart of this approach lies international law, which not only facilitates cooperation and coordination among nations but also serves as a pivotal platform for addressing the complex challenges posed by the WEF nexus. If the interactions and trade-offs amongst policy objectives across various sectors are not duly addressed and policy consistency is not achieved, the strain on resource systems will considerably grow [4]. The interlinkages and interactions among WEF sectors have long been acknowledged in other disciplines, such as natural sciences, whereas it is only beginning to draw attention in legal research [5].

Complex situations such as those of the WEF nexus, which are mostly related to situations that take place at the basin and regional levels, need a more context-specific regulation to strike a balance between global and local regulations. Although the WEF nexus is exemplary of the ever-growing connection between global and local concerns and of the growing research in the area of comparative international law, transnational law, and of the interconnections between law and other disciplines, it is only now that lawyers and legal scholars are considering it from a legal global and domestic lens [6]. In the context of the Arctic, it is unlikely to find any studies that examine the WEF nexus from a legal perspective.

The main challenge in the governance and regulation of water, energy, and food is that it is enforced through separate frameworks and instruments where the sectoral approach and divide is the dominant one. The nature of the WEF nexus is usually context-specific as the interlinkages between the three sectors usually occur at the basin and regional levels and not the international level [6]. Moreover, science and technology are creating possible interferences and overlaps among several different legal fields in these sectors [7]. Hence, it is not easy to determine the legal implications and the interdependencies among these different and sometimes diverging fields. Correspondingly, two significant issues should be considered during the course of law and policymaking to achieve harmony within the WEF nexus to avoid conflict of laws, and to account for the social and political aspects [8].

This study, serving as the first WEF nexus approach study in international law conducted in the Arctic, investigates the complex and integrated dimensions of WEF nexus from an international law perspective at regional, international, and national levels in a transboundary context given not only the existence of diverging interests and values of governments as well as that of Indigenous peoples and other resource-dependent Arctic communities, but also the different and equally important global common goods represented within the WEF nexus itself. In addition, our paper seeks to enhance regulation of the WEF nexus in the Arctic from the standpoint of international law that considers the interconnectedness and cross-sectoral interactions between water, energy, and food for resource planning and for developing effective policies.

The primary goal of this study is to identify the legal means available within the corpus of international law and further examine how they can effectively address the existing challenges within a WEF nexus approach. Apart from an analysis of the existing international legal frameworks relating to the WEF nexus, this study also builds on the studies developed previously by other scholars in relation to international law being in support of the nexus approach to WEF, e.g., [1,9]. This study argues that international law provides the essential means to address a nexus approach to WEF and its pertinent issues and complexities in a transboundary context. In the Arctic region, these international legal means help address complexities and challenges of the WEF systems from a legal standpoint. Furthermore, focusing on how to regulate the WEF nexus at the transboundary scale, our study indicates that already existing means in international law can regulate a nexus approach to WEF in the Arctic with an improved coordination of different regulations, rules, and treaties given the complexity and the need for harmony among different values, treaties, legal systems, and the strong influence of ever-changing science and technology in this region.

2. Materials and Methods

This paper builds mainly on document analysis. Various international instruments and documents were examined: international bilateral and multilateral agreements; conventions; treaties; protocols; annexes; amendments; judgments and advisory opinions of international tribunals; as well as separate opinions of judges of those tribunals; general comments; reports; strategic frameworks; issue papers; etc. All these provide the legal substances, procedures, and practices pertinent to a nexus approach to WEF in a transboundary context applicable to the Arctic. Some of these instruments are specifically established by the Arctic states and/or designed to be applicable in the Arctic (e.g., the

1929 Convention between Norway and Sweden on Certain Questions relating to the Law on Watercourses; the 1961 agreement between the United States and Canada regarding the Columbia River Basin: Cooperative Development of Water Resources; the 1981 AGREEMENT between Finland and Norway on Finnish–Norwegian border water commission; and the 1964 Agreement Concerning Frontier Watercourses between the Finnish Republic and the Soviet Union).

Some others are established within other international frameworks and/or with a broader scope of application that also have applicability in the Arctic (e.g., 1966 International Covenant on Economic, Social, and Cultural Rights; the 2007 United Nations Declaration on the rights of Indigenous Peoples; and the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes). Other instruments that were studied have no direct applicability in the Arctic but can be characterized as exemplary international arrangements within the WEF nexus discourse in transboundary settings (1995 Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin). Some of the instruments were instituted with the contribution of the Arctic Council (e.g., the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic (MOSPA) and Agreement on Enhancing International Arctic Scientific Cooperation), and others that were adopted under the auspices of other international forums and institutions (e.g., The Helsinki Rules on the Uses of the Waters of International Rivers, and Berlin Rules on Water Resources).

Within the corpus of international law, international water law is central in the WEF nexus discourse, as it forms the primary pilar of the nexus. Hence, instruments on international water law were given particular attention in this study. These international instruments often encompass principles such as the equitable and reasonable utilization of shared resources, the no harm principle, the good faith principle, and the principle of good neighborliness that are the driver of our argument in this paper. Our list of instruments is not exhaustive, nor is our analysis of a WEF nexus approach in the Arctic. Rather, it is an entry point to the discourse. Thus, there are arguably other instruments or provisions within other international instruments that can be applied to support a WEF nexus approach in the Arctic from an international law perspective.

In addition, this study also builds on a literature review. Several articles on WEF nexus discourse (concept, management, governance, case studies, etc.), international water law, international human rights law, right to water, right to food, right to energy, Indigenous rights law, and other relevant literature available largely in social and natural sciences, as well as a few legal and policy studies, were examined. In the scope of the Arctic, no study specifically addresses the legal aspects of the WEF nexus. In regard to the Indigenous peoples, several instruments were examined. Some of them were adopted within the domain of the United Nations and other overarching international multilateral institutions (e.g., United Nations Declaration on the rights of Indigenous Peoples, and Human rights to safe drinking water and sanitation of Indigenous Peoples: State of affairs and lessons from ancestral cultures), and some specifically aimed at Indigenous peoples and local communities in the Arctic (e.g., the 2019 Arctic and Northern Policy Framework [10]).

Moreover, semi-structured interviews and dialogues were conducted using the email interview technique with experts, researchers, and practitioners in the fields of international law, Arctic law and policy, WEF nexus, and resource security, as well as Indigenous rights. A set of guiding questions was prepared in advance to use with each dialogue and interview aiming to explore the challenges and scenarios of WEF nexus governance in international law as applicable in the Arctic. This technique allowed the participants to respond to the questions in a timely manner at their own pace, enabling them to contemplate each question thoroughly and provide well-thought responses. It is worth noting that the respondents were given the choice of either a face-to-face or an email interview between which they selected e-mail owing to the time management, flexibility, comfort, and control. This technique was also beneficial in terms of the possibility to pose open-ended questions and specially follow-up questions based not only on the responses received from one particular

participant but on the responses from others too. Additionally, the respondents suggested some useful relevant documents and sources.

3. Water, Energy, and Food (WEF) Nexus Governance: An Overview

The WEF nexus is presented as a governance approach and is aimed at addressing complex and interconnected resource management challenges [11]. This governance stands as a critical endeavor at the intersection of global challenges in the 21st century in support for effective resource management policies. As such, the WEF governance approach has witnessed a growing interest in its application in decision making within the recent decade mainly due to rising demand for the water, energy, and food; growing impacts of the global climate change; human rights considerations; and the necessity for a consistent and comprehensive realization of sustainable development goals (SDGs) [1,12]. During the same period, the discourse within the WEF nexus has developed from focus on WEF security and resource scarcity see, inter alia [13,14] to economic rationality and resource use efficiency and optimization [14,15].

WEF nexus governance accounts for how different functions in one WEF sector can impact the other(s). Importantly, the nexus accounts for the likelihood that decisions, actions, and projects in one sector may have negative impact on the vulnerable populations including women, children, and Indigenous communities [1]. In a transboundary context, the avenue to achieve that, as set forth by the UN Economic Commission for Europe (UNECE), is integration of or coordination among institutions, information and research, instruments, infrastructure, and international cooperation across the sectors [16]. To ensure the realization of objectives, the nexus approach encompasses some principles, as a core set of features, ranging from collective efforts and participatory practices to sound scientific analysis, knowledge mobilization, and capacity building [17], all of which are subject to cooperation among relevant sectors in the riparian countries.

Furthermore, the WEF nexus is framed as a tool to achieve SDGs see inter alia: [1,18], enabling policymakers to attain a holistic understanding of the trade-offs and synergies among the SDGs by special attention to enhanced collaboration among elements within each sector, thus avoiding redundant sector-specific decisions, actions, and programs. Moreover, the nexus establishes a unified platform for the pursuit and implementation of international commitments related to WEF security, which is outlined in various international instruments.

The WEF nexus is advocated as a governance approach for addressing intricate challenges in management of WEF resources see, inter alia [4,13], and has achieved success in expanding integrated governance attentions beyond water sector into food and energy with an inclusive approach as to the diversity of institutions, stakeholders, and decision makers involved. Nonetheless, it has not been very successful as a consistent governance and regulatory notion [19]. This is why a large portion of the WEF nexus governance discourse in international law spans predominantly around how to address fragmentation of the rules and regulations within the international legal instruments of each WEF sector to achieve coherence as a nexus [1]. On the positive side, while international law allows for the interpretation of those international legal instruments in favor of a nexus approach to WEF, the rules for the interpretation of international law obligations, as stipulated in the 1969 Vienna Convention on the Law of Treaties [20], can be used to address the issue of fragmentation and opens avenue to achieve governance coherence.

Although international law has shortcomings in explicitly addressing the interlinkages among food, energy, and water [9], it offers a robust spectrum of means to effectively address the complex and interconnected challenges of the WEF nexus. Central to this approach is the framework of international agreements and conventions that promote cooperative governance among nations. These international instruments often encompass principles such as equitable and reasonable utilization of shared resources [21,22], transboundary cooperation [21,22], and no harm [21,22]. Moreover, international law provides

mechanisms for negotiation and dispute resolution, enabling nations to reconcile competing interests and develop shared strategies for managing the WEF nexus sustainably.

Nevertheless, international legal instruments can incorporate specific provisions related to the WEF nexus, facilitating holistic and integrated resource management, particularly given the growing recognition of human rights to water and food within international law see inter alia: [23–25] that underscores the importance of these resources in the context of the WEF nexus, offering a legal foundation for equitable access and sustainability. In essence, international law not only accommodates but actively supports the nexus approach [9], offering the necessary means for nations to navigate the complex web of WEF interdependencies while promoting global cooperation and resource security.

4. Means Available in International Law to Address a WEF Nexus Approach

In addressing the intricate complexities that exist within water, energy, and food resources, international law offers a diverse array of means that span a spectrum of legal rights, principles, and obligations. This multifaceted approach within international law serves as a powerful framework for fostering a nexus approach to WEF. This section delves into several key facets of international law, each with its own distinct contribution, that collectively facilitate the pursuit of sustainable WEF interdependencies and global resource security. From recognizing vital human needs and human rights to fostering cooperation and promoting equitable resource utilization, these means and principles not only shape the legal landscape but also underscore the imperative of a holistic approach to addressing the complex challenges of the WEF nexus.

4.1. The Vital Human Needs

The requirement to fulfill vital human needs within the framework of international law is considered to be a powerful tool to effectively address the WEF nexus. At the core of this approach is the acknowledgment that water, food, and energy must initially be allotted to meet vital human needs. In accordance with Article 10 of the Convention on the Law of the Non-Navigational Uses of International Watercourses (UN Watercourses Convention), in situations where a conflict occurs among different usages of a transboundary/international watercourse, *vital human needs* must be given special regard [22]. That is, when a conflict arises in regard to the relationship among different kinds of uses of a transboundary watercourse, in the absence of an agreement or a custom to the contrary between watercourse states which prioritizes one use over another, "special attention is to be paid to providing sufficient water to sustain human life, including both drinking water and water required for the production of food in order to prevent starvation" [26].

Article 3 of the Berlin Rules on Water Resources (Berlin Rules) defines 'vital human needs' as "waters used for immediate human survival, including drinking, cooking, and sanitary needs, as well as water needed for the immediate sustenance of a household" [23]. In Article 14, Berlin Rules explicitly states that satisfaction of vital human needs must be the first priority in determining an equitable and reasonable use of water resources both at national and international levels [23]. The term 'drinking water' in international law typically refers to water utilized not solely for drinking purposes but also for other purposes, such as food preparation and cooking, personal sanitation and domestic uses, household hygiene, and other essential human needs [27,28].

Consequently, fulfillment of vital human needs in international law requires states to provide access for individuals to sufficient, safe, acceptable, physically accessible, and affordable water. This is an obligation upon states that has been recognized also in the UN General Assembly Resolution 64/292 [29], as well as other international instruments suggesting that international law provides adequate means to safeguard these vital human needs. In addition, prioritizing different water uses to address vital human needs not only aligns closely with a nexus approach to WEF, which seeks to ensure the human right to water and to food [30], but indirectly endorses it with "mandating the satisfaction of vital human needs as the first priority of water" [31]. This urges states to adopt holistic and

sustainable resource management practices that address the intricate interdependencies of the WEF nexus. In doing so, international law plays a pivotal role in guiding states towards a more integrated, equitable, and rights-based approach to securing the essential elements of human wellbeing.

4.2. The Human Right to Water, Food, and Energy, and Basic Human Needs

The human right to safe drinking water have been recognized in the United Nations Charter Articles 55 and 56 [32], General Assembly Resolution 64/292, Human Rights Council Resolution 15/9, General Comment 15 of the Committee on Economic, Social and Cultural Rights (CESCR) on the Right to Water, General Assembly Resolution 70/169, and Human Right Council Resolution 33/10. The right to water and food has been affirmed through various international instruments, including the Universal Declaration of Human Rights [33] and the International Covenant on Economic, Social, and Cultural Rights [34]. These instruments enshrine the criterion of availability, quality, acceptability, accessibility, and affordability, emphasizing the importance of ensuring that all individuals have access to a sufficient quantity of safe drinking water [27] and nutritious food [35]. In the context of the WEF nexus, the human right to water and human right to food is, respectively, considered the most important human right.

As stated in General Comment 15 of CESCR, the right to water as a normative concept includes both *freedoms* and *entitlements*. The *freedoms* involve "the right to maintain access to existing water supplies necessary for the right to water, and the right to be free from interference, such as the right to be free from arbitrary disconnections or contamination of water supplies" [36]. The *entitlements* involve "the right to a system of water supply and management that provides equality of opportunity for people to enjoy the right to water" [36]. As to Article 17 of Berlin Rules "every individual has a right of access to sufficient, safe, acceptable, physically accessible, and affordable water to meet that individual's vital human needs" [23]. In addition, Agenda 21 of U.N. Conference on Environment and Development (Agenda 21) states that "all peoples, whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs" [24].

Among other uses, water is also required to ensure the right to food [36,37] in that it is essential to produce food. The right to food has been recognized in various international instruments, including the International Covenant on Economic, Social and Cultural Rights (ICESCR), which establishes the right of everyone to adequate food. In line with ICESCR, General Comment 12 of the CESCR highlights that ensuring sustainable access to water for agricultural purposes is crucial in achieving the right to adequate food [37]. It also emphasizes that "the human right to adequate food is of crucial importance for the enjoyment of all rights" [37].

In realization of the right to adequate food, every individual should have physical and economic access to adequate food or means for its procurement at all times [37]. The right to food, which should not be interpreted strictly, requires states to act promptly towards achieving this objective, while also ensuring every individual within the scope of their jurisdiction have access to adequate, nutritious, and safe food. Importantly, this right levies three levels of obligations upon states, including obligations to respect, to protect, and to fulfil [37]. The obligation to *respect* requires states to ensure that existing access to adequate food is maintained. The obligation to *protect* requires states to ensure that nothing can deprive individuals of access to adequate food. The obligation to *fulfil* encompasses two obligations to *facilitate* and to *provide*. While the former obligation requires states to proactively *facilitate* and strengthen people's access to food resources and ensure their food security, the latter requires states to *provide* the right to food directly in circumstances where individuals are unable to enjoy that right due to reasons beyond their control [37].

In a transboundary and international context, states need to concurrently account for the realization of this right for the individuals living in other countries too by not only refraining from actions that may deprive them from access to food resources, but by

facilitating their access and delivering necessary aid to them in necessary circumstances [37]. Moreover, they should ensure this right within existing international instruments where relevant and also consider adoption of additional international legal frameworks when needed. Likewise, states are required, in line with the UN Charter and the ICESCR provisions as well as several other relevant international instruments, to acknowledge the significance of international cooperation in fulfilment of the right to food within a transboundary context [37].

Water is also necessary to ensure basic human needs, including the right to health, right to earn a living by work, and right to take part in cultural life. Among other uses, however, the right to water for personal and household uses must be given the foremost consideration in water allocation [36]. Through embedding these rights in international law, the WEF nexus approach gains a firm legal foundation that obliges states to prioritize the equitable distribution of water and food resources. This recognition underscores the necessity of considering the interconnections between these resources and the energy sector, as energy is an essential component in the production, distribution, and access to food and clean water [9,11,31,38].

Unlike the rights to water and food, the discourse on the right to energy is less developed. Nevertheless, in the contexts of energy security, equitable and reasonable utilization of energy resources, energy justice, principles governing competing uses of energy, due diligence duty, energy poverty, duty to cooperate, access to energy, and no harm principle, there is a considerable amount of research and literature available. Moreover, the human right to energy is closely intertwined with the rights to water and food, as well as basic human needs such as right to adequate standard of living for an individual and his/her family and right to health [34]. This refers to the fundamental entitlement of every individual to access clean, affordable, and reliable energy sources for various aspects of life, including cooking, heating, lighting, and powering essential appliances and services [38].

Without energy, it can be challenging to pump, treat, and distribute water to communities. Energy is essential for running water treatment plants, ensuring water quality, and maintaining the infrastructure needed to deliver water to households [38]. Similarly, Energy plays a crucial role in agriculture, from powering machinery and irrigation systems to preserving and transporting food. It is required for cooking, which is essential for food preparation. Without energy, it can be difficult to ensure food security and meet the nutritional needs of a growing population. Energy is a key enabler for meeting basic human needs, such as heating and cooling, ensuring safe living conditions, and powering medical equipment in healthcare facilities.

The interconnection between these rights and energy highlights the importance of considering them within a WEF nexus perspective [13]. Both international human rights law and international water law endorse a WEF nexus approach, as it contributes to the protection of human rights within those sectors. This contribution is realized not only by prioritizing various WEF uses, but also by offering solutions to global resource scarcity through special consideration of interactions, synergies, and trade-offs within WEF sectors. Further, policies and decisions related to these three sectors must be made coherently to ensure that the pursuit of one right does not inadvertently compromise another. Additionally, addressing the WEF nexus can help in achieving sustainable development goals and promoting equitable access to these essential resources, ultimately contributing to the realization of basic human rights for all.

4.3. The No Harm Principle

No harm is a customary principle of international law, binding upon all states, that plays a significant role in addressing a WEF nexus approach. According to the no harm principle, watercourse states cannot utilize a transboundary watercourse in a way which causes harm to other states. The no harm principle becomes particularly relevant when considering the interconnected nature of water, energy, and food resources across borders in that the drive to advance national interests in one state should not hinder the reasonable

and equitable utilization of shared watercourses by other states, and should not inflict considerable damage on them [21,23,39].

Article X of the International Law Association's the Helsinki Rules on the Uses of the Waters of International Rivers (ILA Helsinki Rules) reads that states "must prevent any new form of water pollution"—originating either within or outside the territory of that state, if it is caused by that state's conduct—"or any increase in the degree of existing water pollution in an international drainage basin which would cause substantial injury in the territory of a co-basin state, and should take all reasonable measures to abate existing water pollution in an international drainage basin to such an extent that no substantial damage is caused in the territory of a co-basin State" [39]. While states, according to customary international law and treaty law, can equitably and reasonably use a shared watercourse, they are required to ensure that no significant harm is inflicted on the co-riparian states [40].

The no harm principle helps in balancing the interests of states in managing their own WEF resources with the need to prevent harm to neighboring states. It encourages states to consider the potential transboundary impacts of their policies and activities in the WEF sectors. For instance, the construction of dams or extraction of water or energy resources in one state can have significant consequences for downstream states in terms of water availability, energy production, or food production, or in circumstances where a water storage facility in one riparian state is likely to draw significant amounts of water from a shared watercourse, potentially disrupting its natural flow or quality in another riparian state; such extraction could be considered harmful in international law [22,23,31].

Here, the relationship between the no harm principle and the principle of equitable and reasonable utilization becomes imperative. While states are entitled to equitable and reasonable utilization of a shared watercourse, such utilization is contingent upon ensuring that no significant harm (e.g., water pollution) is inflicted on other riparians. Therefore, the threshold is the *impact* of the utilization activities which should not exceed a *significant* level. In case such a significant harm is inflicted, for instance, by a state building a dam on a shared watercourse as a result of which the flow, quality, or access to water is harmed for the co-riparian state who uses that water for agriculture and food production, the former is required to take necessary actions in eliminating and mitigating the impacts or compensating for those significant harms to the latter, because the harm in question is risking not only water security but also food security of that state.

4.4. The Duty to Cooperate

The duty to cooperate is one of the main normative pillars of international law, as reflected in Article 1(3) of the UN Charter. It underscores the responsibility of states that share a watercourse to collaborate in managing and governing the utilization of the watercourse and its resources in an equitable and reasonable manner without causing any significant harm [9]. Therefore, the duty to cooperate is exceptionally important because much of the discourse within the WEF nexus in international law relies directly or indirectly on cooperation and constructive negotiations [41].

Article 2.6 of the 1992 UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) requires states of a shared watercourse to "cooperate on the basis of equality and reciprocity, in particular through bilateral and multilateral agreements, in order to develop harmonized policies, programmes and strategies aimed at the prevention, control and reduction of transboundary impact and aimed at the protection of the environment of transboundary waters or the environment influenced by such waters, including the marine environment" [21]. Article 9.2 of Water Convention takes the obligation a step further by setting out establishment of joint bodies by the riparian states within the above-said multilateral and bilateral arrangements.

The function of the joint bodies includes collecting and analyzing relevant data and information to identify sources of pollution. They formulate shared objectives regarding water quality and set limits for wastewater emissions [21]. Additionally, they oversee monitoring systems for both the quality and quantity of water. They also establish a

collaborative program of actions for control, emergency warnings and responses, and mitigation in the event of pollution incidents [21]. These joint bodies also act as platforms for sharing data and information about actions, programs, or installations that may entail transboundary impacts. They support collaboration, knowledge, and technology, sharing guidelines and participating in the implementation of the international regulations with respect to environmental impact assessments of transboundary watercourses [21].

As per Article 8 of the UN Watercourses Convention, watercourse states are required to "cooperate on the basis of sovereign equality, territorial integrity, mutual benefit and good faith in order to attain optimal utilization and adequate protection of an international watercourse" [22]. In so doing, the UN Watercourses Convention also urges states to establish and utilize joint arrangements. Accordingly, states are urged to "consider the establishment of joint mechanisms or commissions to facilitate cooperation on relevant measures and procedures in the light of experience gained through cooperation in existing joint mechanisms and commissions in various regions" [22].

An example of such joint cooperation mechanisms can be found in the case of the 1995 Mekong Agreement. The Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin (1995) emphasizes a joint and basin-wide approach to development projects aiming at the full potential of sustainable benefits to its member countries. As set forth in Article 1, this agreement develops a wide range of cooperation "in all fields of sustainable development, utilization, management and conservation of the water and related resources of the Mekong River Basin, including, but not limited to irrigation, hydro-power, navigation, flood control, fisheries, timber floating, recreation and tourism, in a manner to optimize the multiple-use and mutual benefits of all riparians and to minimize the harmful effects that might result from natural occurrences and man-made activities" [42,43].

In the framework of a WEF nexus approach, the duty to cooperate extends beyond merely addressing water-related issues. It necessitates recognizing that decisions and actions in one sector, such as constructing dams for energy generation or irrigation for food production, can have profound impacts on the availability and quality of water downstream [22,23,31]. Thus, developing joint approaches and institutions for cooperation such as that of 1995 Mekong Agreement becomes significant within the WEF nexus to ensure resource security. Riparian states are not only obligated to protect the water rights and interests of their neighbors but also to coordinate policies and practices that ensure the sustainable use of water resources while simultaneously meeting their energy and food security needs.

In order to utilize the potential of duty to cooperate in international law to implement a nexus approach to WEF, UNECE has provided assessment guidelines to help reconcile various WEF resource uses in transboundary basins. These include identifying and, when necessary, analyzing basin conditions, the nexus's socioeconomic context, its key sectors and stakeholders, its intersectoral issues, the opportunities for improvement across the sectors and countries, and the nexus's dialogue and future developments [16]. The primary objective of this assessment is "to describe the different options for reducing negative impacts and to take advantage of complementarities and opportunities for cooperating and sharing benefits. These are normally basin specific, which means that the analysts need to be ready to consider a variety of interlinkages" [16].

Accordingly, a nexus approach to WEF from an international law perspective is in conformity with the duty to cooperate, in that it requires states to cooperate in good faith through establishment of joint arrangements and institutions. Through effective cooperation, watercourse states can optimize the management of their WEF resources, prevent conflicts, and advance shared goals of environmental sustainability, poverty reduction, and regional stability. International law imposes a duty of cooperation upon states in sharing natural resources and the first step is to try to solve possible conflicts of laws and regulations due to the separate rules applied to water, energy, and food [6]. The different legal regimes applicable to these resources are still under development, which may provide

an opportunity for a great harmonization and the consequent inclusion of new provisions and principles [6]. This underscores the critical role of international law in promoting a balanced and harmonious approach to addressing the complex challenges posed by a nexus approach to WEF.

4.5. The Principle of Equitable and Reasonable Utilization of Transboundary Watercourses

The equitable and reasonable utilization is a principle of international law that governs the management of transboundary water resources among watercourse states, according to which states have both entitlement and obligation in equitable and reasonable use of shared waters. The equitable and reasonable utilization is the overarching rule of treaty and customary law which requires states sharing a transboundary watercourse to participate in the use, development, and protection of an international watercourse in a sustainable and optimal manner that is equitable and reasonable, ensuring that the needs of all riparian states are met [22]. Such participation incorporates both the right to use the watercourse and the duty to cooperate in the protection and development of the watercourse in question [22].

Furthermore, states need to account for factors and circumstances applicable to this principle as set forth in Article 6 of UN Watercourses Convention. These include "geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character, the social and economic needs of the watercourse states concerned, the population dependent on the watercourse in each watercourse state, the effects of the use or uses of the watercourses in one watercourse state on other watercourse states, existing and potential uses of the watercourse, conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect, and, the availability of alternatives, of comparable value, to a particular planned or existing use" [22]. The ILA Berlin Rules add two more factors to this list: first, the use should be sustainable; second, it should involve minimum harm to the environment [23].

Although energy and food sectors are not explicitly mentioned in the factors enumerated in Article 6 Paragraph 1 of the UN Watercourses Convention as well as those of ILA Berlin rules, it is implied from the inclusion of factors such as 'the social and economic needs of the watercourse states', 'existing and potential uses of the watercourse', 'conservation, protection, development, and economy of use of the water resources of the watercourse and the costs of measures taken to that effect', as well as 'the availability of alternatives, of comparable value, to a particular planned or existing use' regarding the utilizations of food and energy sectors are also taken into consideration [22]. The equitable and reasonable utilization principle acknowledges that watercourses are not only essential sources for drinking water and food production, but also utilized for energy production through hydropower generation. It therefore encourages states sharing a transboundary watercourse to negotiate and cooperate, considering the unique conditions and vulnerabilities of each riparian state.

4.6. The Duty to Protect and Preserve the Environment of the Watercourse

The duty to protect and preserve the environment of the watercourse is the least discussed among other means available in international law to address a nexus approach to WEF by the international law scholars. This duty is a fundamental principle in international law, and its pertinence in transboundary basins is particularly salient within the context of the WEF nexus. While this duty is akin to and related to the no harm principle, it is clearly distinct from this [44]. This duty necessitates that states sharing a common watercourse take collective responsibility for safeguarding the ecological integrity of the basin.

The UN Watercourses Convention requires states to "individually and, where appropriate, jointly, protect and preserve the ecosystems of international watercourses [22]. Accordingly, watercourse states shall, individually and, where appropriate, in cooperation with other States, take all measures with respect to an international watercourse that are necessary to protect and preserve the marine environment, including estuaries, taking into account generally accepted international rules and standards" [22]. The above terms in the

UN Watercourse Convention resemble the provisions under Part XII of the United Nations Convention on the Law of the Sea (LOS Convention) on the Protection and Preservation of the Marine Environment [45]. This similarity is noteworthy because it signals the relevance of the case law on Part XII of the LOS Convention in terms of watercourses [44]. The duty stated in the UN Watercourse Convention, much like the one stated in the LOS Convention, are expressions of the broader duty of due diligence and of the principle of prevention of significant environmental harm [44]. Their grounding in customary international law has been repeatedly recognized, including in cases specifically dealing with the use of international watercourses [44].

Any damage to the environment of an international watercourse can have significant repercussions on the water, food, and energy security of riparian states. It can reduce the availability and degrade the quality of water in the basin, impact drinking water supplies and reduce the amount of water available for irrigation, which is crucial for food production [31]. Decreased water availability also affects hydropower generation, impacting energy production [46]. Agriculture relies heavily on water resources from river basins. Environmental damage can disrupt irrigation systems, decrease soil fertility due to contamination, or lead to water scarcity, all of which can reduce crop yields and threaten food security. Many countries depend on hydropower as a source of electricity. Environmental damage to a water basin can alter river flow patterns, reducing the efficiency of hydropower generation and potentially leading to energy shortages. In addition, healthy river ecosystems provide essential services like water purification, flood control, and habitat for fisheries. Environmental damage can disrupt these services, making it difficult to ensure safe drinking water, manage flood risks, and sustain fisheries that contribute to food security.

In cases such as ones related to hydroelectricity projects, where actions in one sector can profoundly impact the environment and thus the availability of water for other critical purposes like energy and food production, the duty to protect and preserve the environment acquires paramount importance. It obligates basin states to adopt measures that ensure the sustainable use of water resources, mitigate environmental degradation, and minimize adverse cross-sectoral impacts. By fulfilling their duty to protect and preserve the basin's environment, states not only bolster their ecological resilience but also pave the way for a balanced and harmonious approach to addressing the multifaceted challenges posed by the WEF nexus in transboundary basins.

4.7. Good Faith Principle

The good faith is a fundamental principle of international law, acknowledged by the ICJ as a well-established international law principle [47]. The principle of good faith takes on added significance when applied to transboundary basins within the context of the WEF nexus. This principle underscores the expectation that states sharing a watercourse should engage in negotiations and cooperative efforts based on trust and confidence with a view to achieve mutual benefits [30,41,48]. In the context of the WEF nexus, where the allocation and management of water resources deeply impact energy and food production, acting in good faith becomes paramount.

In setting out general obligation for cooperation among watercourse states, the UN Watercourses Convention requires states to cooperate on a number of bases, including on the basis of *good faith* "in order to attain optimal utilization and adequate protection of an international watercourse" [22]. Under this obligation, basin states are required to communicate transparently, share information, and collaborate in a manner that respects the interconnectedness of water, energy, and food systems. Moreover, when negotiating the possible effects of planned measures on the condition of an international watercourse, each riparian state is required to conduct consultations and negotiations on the basis that pay reasonable regard *in good faith* to the rights and legitimate interests of the other state [22].

In the arena of information exchange between riparians, the UN Watercourses Convention requires watercourse states to cooperate in good faith with a view to providing

each other as much information as possible [22]. Within the framework of sustainable development in international law, the 1992 Rio Declaration on Environment and Development requires states to "cooperate in good faith and in a spirit of partnership in the fulfilment of the principles embodied in this Declaration and in the further development of international law in the field of sustainable development" [49]. Upholding the good faith principle, states can establish a solid foundation for addressing the complexities of the WEF nexus, fostering trust, and working together to achieve sustainable and equitable solutions for all stakeholders involved in transboundary basin management.

International case law is also in support of the adherence to good faith principle in the WEF context. The ICJ in its decision on the case pertaining to the dispute between Hungary and Slovakia concerning the Gabčíkovo–Nagymaros project (a hydroelectric dam project on the Danube River) had the occasion to address the negative transboundary impact of the Gabčíkovo–Nagymaros hydropower plant project under international law. This was originally a joint project (between former Czechoslovakia and Hungary in 1977) whose purpose was "the broad utilization of the natural resources [47] of the Danube River for the development of water resources, energy, transport, agriculture and other sectors of the national economy of the contracting parties" [47]. The court adjudicates "that Hungary and Slovakia must negotiate *in good faith* in the light of the prevailing situation, and must take all necessary measures to ensure the achievement of the objectives of the Treaty of 16 September 1977, in accordance with such modalities as they may agree upon" [47].

4.8. The Principle of Good Neighborliness

The principle of good neighborliness in international law is both impliedly and expressly integrated into the UN Charter [50]. The UN Charter describes it as "the general principle of good neighborliness, due account being taken of the interests and wellbeing of the rest of the world, in *social, economic, and commercial matters*" [50]. This principle assumes particular importance when applied to transboundary basins. The no harm principle can be considered as being part of the principle of good neighborliness in international law [41]. Good neighborliness as a fundamental principle of international law is a condition that requires the development of normal relations between geographically adjacent states. Interestingly, rules governing the relationship between neighboring countries can be categorized amongst the first rules established in international law [51].

The International Court of Justice, "from the very commencement of its jurisprudence, has supported the principle of good neighborliness by spelling out the duty of every state not to allow knowingly its territory to be used for acts contrary to the rights of other States" [41,50,52]. The Water Convention also includes important obligations as to the principle of good neighborliness. In setting out conditions for consultation between the watercourse states, the Water Convention requires the riparians to consult with each other "on the basis of reciprocity, good faith and *good-neighborliness*" [21]. This principle advocates that states sharing a common watercourse should maintain harmonious, cooperative, and respectful relations with one another.

In the WEF nexus context, where water resources significantly impact energy and food security, maintaining positive neighborly relations becomes essential. This principle encourages basin states to engage in open dialogue, share benefits, and collaborate on sustainable management practices that account for the intricate interplay between water, energy, and food systems. Through adhering to the principle of good neighborly relations, states can not only prevent disputes but also enhance regional stability, promote equitable resource allocation, and ensure the wellbeing of communities reliant on transboundary basins for their livelihoods and basic needs.

5. WEF Nexus and International Law in the Arctic

The WEF nexus can be contextualized within international law through the acknowledgement of its interdisciplinary nature and the challenges it presents to traditional legal frameworks. This approach recognizes the interconnectedness and interdependence of

WEF systems [53]. Yet, the existing legal frameworks often operate within sectoral boundaries and fail to adequately address the complex interactions, synergies, and trade-offs within the WEF nexus [54].

The objective of a nexus approach to WEF in the Arctic should be to reconcile the different water uses in transboundary basins and ensure the security of WEF. It also should aim to effectively manage sustainable development in that region benefiting Indigenous communities and riparian states alike [1,10,11,31,55]. Hence, an analysis of WEF nexus governance should accordingly account for the conditions under which there is successful coordination among multiple interlinked decision/action situations pertaining to those different rights and uses [4]. In so doing, traditional livelihoods must be accounted for not only from an economic standpoint, but also from social, cultural, environmental, and spiritual perspectives.

Considering the impact of global processes on the Arctic's resources, it is important to make the connection between global work on sustainable development, on the one hand, and Arctic work on the other [56]. While this approach has been taken by the Arctic Council as a priority to account for the UN-SDGs to serve as the Arctic Council's guiding framework, one should be wary that the global sustainable development frameworks still do not reflect the Arctic's priorities [56,57]. Hence, the Arctic Council's Sustainable Development Working Group (SDWG) "identifies, proposes and adopts steps to be taken by the Arctic Member States and Permanent Participants to advance sustainable development in the Arctic, including opportunities to protect and improve the state of the environment, and enhance the economies, cultures and health of Indigenous Peoples and other Arctic residents, as well as to improve the environmental, economic and social conditions of Arctic communities as a whole" [57].

To accomplish these objectives—and many more that are embedded within a nexus approach to WEF—international law, particularly international water law, presents a beneficial platform for cooperation among states and various sectors that aim to safeguard WEF security [30]. International law offers a set of robust means of legal norms to effectively address the intricate nexus of WEF issues in a transboundary context, as well as to navigate the specific challenges posed by these systems in regions such as the Arctic. These legal means have evolved over time in various contexts of international law, such as international water law, international environmental law, human rights law, etc., to accommodate the ever-increasing interdependence of WEF sectors. For instance, transboundary water agreements and conventions, such as the UN Watercourses Convention and the Water Convention, provide a legal foundation for equitable sharing and responsible management of water resources among states. In the Arctic, where climate change is dramatically affecting water availability, these agreements can guide cooperative strategies for sustainable water resource management, ensuring that the needs of both Indigenous communities and riparian states are met while considering energy and food production needs.

However, this area of law with its set of legal norms is not evidently distinguishable but a rather fragmented group of customary, international, regional, and national rules [9,58]. International law does not provide many explicit interlinkages among WEF sectors as exists in a nexus approach, and the relevant WEF regulations are often found in various body of provisions in different sectors that may have different functions [9]. Therefore, regulations in one sector, in the context of WEF, may be more developed than others, which is particularly the case in terms of international law governing water sector. In addition, "international water law, as [primarily] codified in the UN Watercourses Convention, provides only a broad framework for states to follow [and] does not explicitly address the trade-offs of water uses across multiple sectors, such as energy and food" [59].

Nonetheless, a WEF nexus approach in the Arctic can provide valuable opportunities to improve WEF security and increase resource productivity in the region. It can provide a normative framework "for reducing the fragmentation of international law obligations relating to water, energy, food, as well as climate change and human rights" [1]. A WEF nexus approach has the potential to establish coherence within governance, institutions,

and policies in the Arctic which per se can lead to capacity building, awareness raising and green growth [13]. Apart from the universally accepted principles and rules of international law which were discussed in Part 4 of this study, two other areas also need to be examined. One is the legal rights and interests of the Arctic Indigenous peoples in regard to the WEF nexus; the other is a selection of key applicable treaty regimes designed and implemented in the Arctic that are also relevant to our study.

5.1. Legal Rights and Interests of Indigenous Peoples

Admittedly, Indigenous peoples have traditional and cultural connections to natural resources in the Arctic endowing them with unique knowledge and perspectives on the management of those resources. They live largely in the area of many Arctic states and have established international organizations—with the status of permanent participants in the Arctic Council—to further their transboundary interests [60]. In the context of a nexus approach to WEF in the Arctic, where Indigenous peoples are predominantly the first group to experience the impacts of WEF sectors, they should be granted the opportunity to participate regardless of their proximity to the transboundary basin in question. Likewise, their rights must be considered in any development in the region. This includes the right to be consulted in good faith and participate in decision-making processes that affect their water resources [61].

This is particularly important in case of the Arctic since a number of studies in recent years have underscored the distinct social, cultural, and economic realities of Indigenous Peoples in various parts of the Arctic region that have gone unnoticed given the relatively high rates of WEF insecurities currently experienced in that region [62,63]. For instance, one study on the Canadian Arctic suggests that this region has been characterized by high rates of WEF insecurity, including limited access to clean water, an overdependence on non-renewable energy sources, and having the highest rates of Indigenous food insecurity among all industrialized nations [63]. According to one study, the Canadian Arctic communities experience higher rates of water, energy, and food insecurity compared not only to the southern part of Canada, but also to the national average [64]. These studies highlight the need to identifying additional alternative indicators within the WEF nexus in the Arctic due to the existing insecurities in parts, if not all, of that region that may be compounded by the social and ecological stresses that are expected to accompany the rapid pace of climate change in the Arctic [63–65].

Regarding natural resources, the 2007 UN Declaration on the Rights of Indigenous Peoples (UNDRIP) encapsulates several articles to ensure protection of the rights of Indigenous peoples to those resources [61]. Importantly, Article 26 requires states to give legal recognition and protection to the lands, territories and resources of Indigenous peoples, while Article 32 obliges states to consult, cooperate in good faith, and obtain the free and informed consent of the Indigenous peoples prior to the approval of any project that may affect their lands, territories, and resources [61].

Similarly, the 1989 Indigenous and Tribal Peoples Convention, in Article 15, urges states to especially safeguard the rights of peoples with respect to the natural resources of their lands [66]. This Convention further states that the rights to natural resources "include the right of these peoples to participate in the use, management and conservation of these resources" [66]. In defining the geographical span of the term '*lands*', the Convention extends the scope of enjoyment and exercise of these rights beyond the total environment of the areas that these peoples *occupy* to also include areas that they otherwise *use* [66]. Thus, these areas also encompass waters [67]. In the Arctic, the scope of the lands of Indigenous peoples, as defined in this Convention, may transcend the boundaries of Arctic states, given that Indigenous peoples' traverse and use of lands and watercourses in that region far predates those boundaries (see Figure 1).

Figure 1. Indigenous peoples in the Arctic (based on Arctic Indigenous languages spoken). Source: Arctic Council Indigenous Peoples Secretariat (IPS).

Furthermore, in accordance with the report of the UN Special Rapporteur on the human right to safe drinking water and sanitation pertaining to human rights to safe drinking water and sanitation of Indigenous peoples, as a result of colonization and violent domination entailing cultural extermination and forced integration into mainstream societies, many Indigenous peoples have been displaced from their territories to areas that are often difficult to access, with fewer resources and harsh living conditions, where states do not, or are unwilling to, provide public services, particularly drinking water and sanitation [68]. This report further puts that the term 'Indigenous Peoples' embodies their beliefs, languages, cultures and livelihoods linked to their traditional territories and, in particular to their *aquatic ecosystems* [68]. Thus, to ensure Indigenous peoples' survival, dignity and wellbeing and to exercise their inherent rights, they must own, conserve, and manage their territories, lands, and resources [68].

In addition, the exceptional knowledge of the Arctic Indigenous peoples on the management of WEF resources necessitates that their rights and traditional knowledge be respected and integrated into decision-making processes [57]. The incorporation of their rights, interests, and traditional knowledge into WEF governance in the Arctic adds another layer of support to the rationale of the need for a nexus approach. It emphasizes that for an appropriate governance of WEF resources, one not only needs to look beyond the traditional and siloed sectoral boundaries of those resources but also beyond the boundaries of the Arctic states. Hence, the traditional knowledge of the Indigenous peoples concerning WEF resources constitutes an indispensable element of a WEF nexus approach.

Moreover, given the uncertainties and complexities associated with the WEF nexus in the Arctic, adaptive governance approaches are crucial. This involves flexible and iterative decision-making processes that can respond to changing conditions and incorporate traditional and new knowledge alike. Adaptive governance can help address the diverging interests and values of different actors by allowing for ongoing dialogue and learning [54]. The incorporation of the rights, interests, and traditional knowledge of the Arctic Indigenous peoples into new knowledge on the governance of WEF can help ensure that its legal intricacies are addressed in a culturally consistent and sustainable manner [69]. This further

can ensure that sustainable, inclusive, and equitable governance of WEF resources in the Arctic is possible.

5.2. Selected Applicable Treaty Regimes

There are numerous treaties, agreements, conventions and other forms of international bilateral and multilateral arrangements with various objectives that are also relevant and applicable within WEF nexus in a transboundary Arctic context. In this section, some of those treaty regimes that are more important in the framework of this research will be briefly introduced, beginning with ones negotiated under Arctic Council auspices and then moving on to those that are not (see Table 1). Among the legally binding international agreements under the auspices of the Arctic Council, two seem to have direct applicability to the WEF nexus.

Table 1. Selected applicable treaty regimes outside the Arctic Council auspices.

Treaty	Main Subject Matter	Members
1929 Norway and Sweden Watercourses Convention	transboundary watercourses	Norway and Sweden
1961 Columbia River Treaty	co-development of Columbia River Basin resources	USA and Canada
1984 Skagit River Treaty	use of boundary waters of Skagit River and Ross Lake	USA and Canada
1909 Boundary Waters Treaty	prevention, resolution and settlement of transboundary waters disputes	USA and (Great Britain) Canada
1981 Finnish Norwegian border water Agreement	use of border water bodies	Finland and Norway
1964 Finnish and Soviet Frontier Watercourses Agreement	governance regime for the use of the common frontier watercourses	Finland and Russia
1971 Finland and Sweden Agreement on Frontier Rivers	enhance transboundary cooperation in water	Finland and Sweden
1957 Pasvik (Paatso) River Agreement	utilization of water power on the Pasvik (Paatso) River	Norway and Russia

5.2.1. Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic

The Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic (MOSPA), signed in 2013 and entered into force in 2016, aims "to strengthen cooperation, coordination and mutual assistance among the Parties on oil pollution preparedness and response in the Arctic in order to protect the marine environment from pollution by oil" [70]. The MOSPA Agreement applies to incidents within the scope of states' "sovereignty, sovereign rights or jurisdiction, including its internal waters, territorial sea, exclusive economic zone and continental shelf, consistent with international law" [70]. While the MOSPA Agreement emphasizes the conservation of natural resources in the Arctic marine and coastal environment and encourages states to cooperate towards that aim, it highlights the significance of sustainable use of such natural resources and the importance of taking precautionary measures to avoid incidents capable of having transboundary impacts.

In relation to transboundary oil pollution incidents, the MOSPA Agreement requires states to cooperate in monitoring efforts through international agreements or other bilateral or multilateral arrangements. This is with the understanding that marine oil pollution poses a threat to the Arctic's marine environment, as well as the livelihoods of Indigenous peoples and other resource-dependent local communities in that region. It not only jeopardizes water security but concurrently threatens food and energy security for the Arctic residents and beyond. The agreement further recognizes that the "Indigenous peoples, local communities, local and regional governments, and individual Arctic residents can provide valuable resources and knowledge regarding the Arctic marine environment in support of oil pollution preparedness and response" [70]. The obligations set forth in the MOSPA Agreement are in conformity with and support of a nexus approach to WEF

in a transboundary context, as they aim to ensure that states, including co-riparians in the Arctic, cooperate in preparedness and have a timely response to marine oil pollution incidents, including those capable of having transboundary impacts.

5.2.2. Agreement on Enhancing International Arctic Scientific Cooperation

The Agreement on Enhancing International Arctic Scientific Cooperation (Arctic Science Agreement), signed in 2017 and entered into force the subsequent year, is another legally binding agreement negotiated under the auspices of the Arctic Council, which is pertinent in the WEF nexus discourse. The purpose of this Agreement is "to enhance cooperation in scientific activities in order to increase effectiveness and efficiency in the development of scientific knowledge about the Arctic" [71]. The geographical scope of application of the Arctic Science Agreement (as indicated in Annex 1: Identified Geographic Areas) includes areas within which State Parties exercise "sovereignty, sovereign rights or jurisdiction, including land and internal waters within those areas and the adjacent territorial sea, exclusive economic zone, and continental shelf, consistent with international law [. . .as well as] areas beyond national jurisdiction in the high seas north of 62 degrees north latitude" [71].

While the Arctic Science Agreement underscores "the importance of the sustainable use of resources, economic development, human health, and environmental protection", it correspondingly highlights "the importance of using the *best available knowledge* for decision making" [71]. This agreement actively promotes not only the utility of the integration of traditional and local knowledge into design and implementation of scientific research, but also communication with holders of such knowledge and the facilitation of their participation. Here, one can argue that the WEF nexus stands out as the *best available knowledge* approach, relying predominantly on its comprehensive consideration of interconnected systems among WEF sectors aiming to achieve policy integrity. It also contributes significantly to resource efficiency, sustainability, adaptability, and resilience.

5.2.3. Convention between Norway and Sweden on Certain Questions Relating to the Law on Watercourses (1929)

The 1929 Convention between Norway and Sweden on Certain Questions relating to the Law on Watercourses, signed on 11 May 1929 and entered into force 2 August 1931, "relates to installations or works or other operations on watercourses in one country which are of such a nature as to cause an appreciable change in watercourses in the other country in respect of their depth, position, direction, level or volume of water or to hinder the movement of fish to the detriment of fishing in the latter country" [72]. This convention establishes preventive procedure against potential negative impacts that may arise from various utilizations of a transboundary watercourse [60]. When planning and deciding to carry out activities such as installations, works, or operations, this convention requires Norway and Sweden to take into consideration the potential effects in *both* countries [72]. The regulations of this convention are well in conformity with and support of the WEF nexus and can contribute to its governance in the Arctic.

5.2.4. Treaty Relating to Cooperative Development of the Water Resources of the Columbia River Basin between the United States and Canada (with Annexes) (1961)

The 1961 Treaty relating to Cooperative Development of the Water Resources of the Columbia River Basin between the United States and Canada (Columbia River Treaty), with its two annexes, signed at Washington on 17 January 1961 and put into force on 16 September 1964, introduces cooperative measures and procedures relating to hydroelectric power generation and flood control in both countries during the course of development and operation of dams in the upper Columbia River Basin [73]. The Columbia River Treaty aims to safeguard access to water in both countries for different water usages and for energy generation. It thereby ensures water and energy security in both countries which per se contribute to food security, ensuring that the right to WEF is protected for the resource-dependent communities in both countries.

5.2.5. Treaty between the United States of America and Canada Relating to the Skagit River and Ross Lake, and the Seven Mile Reservoir on the Pend d'Oreille River (1984)

The 1984 Treaty between the United States of America and Canada relating to the Skagit River and Ross Lake, and the Seven Mile Reservoir on the Pend d'Oreille River (Skagit River Treaty), with an annex, signed on 2 April 1984 and put into force on 30 March 1985, seeks to prevent disputes arising from the use of boundary waters between the US and Canada and to preserve the natural environment of the Skagit Valley in the province of British Columbia [74]. It concurrently seeks to ensure water and energy security for the city of Seattle, which is provided by the Ross Dam on Ross Lake, and for the province of British Columbia, which is provided through the Seven Mile Reservoir on Pend d'Oreille River [74].

5.2.6. Treaty between the U.S. and Great Britain Relating to Boundary Waters, and Questions Arising between the United States and Canada (1909)

The 1909 Treaty between the U.S. and Great Britain Relating to Boundary Waters, and Questions Arising Between the United States and Canada (Boundary Waters Treaty) sets out regulations to prevent and resolve disputes over shared waters between the United States and Canada and to settle other transboundary issues [75]. This treaty establishes the International Joint Commission (IJC) to facilitate implementation of the treaty's provisions. A key responsibility of IJC is to approve any project or work in boundary waters of the two countries that is capable of affecting flows and levels of water on either side of the boundary while monitor the implementation of those projects and render recommendations. Importantly, the IJC's decisions and recommendations should account for the needs of a wide range of water uses, including drinking water and water for household uses, hydroelectric energy generation, agriculture, and ecosystem health [75].

5.2.7. Agreement between Finland and Norway on Finnish Norwegian Border Water Commission (1981)

The 1981 Agreement between Finland and Norway on Finnish Norwegian Border Water Commission, adopted on 1 April 1981 and put into force on 1 May 1981, aims at "preserving the unique natural conditions of the border water bodies and their surroundings and to safeguard the interests of both parties to the agreement and especially the residents of the border region in matters concerning the use of border water bodies" [76]. This includes all rivers, lakes, and brooks traversing the international border of Finland and Norway or otherwise intersected by their international boundaries. This agreement establishes a Boundary Water Commission to facilitate cooperation for the transboundary operation of this agreement. It also implements monitoring and control activities on water quality, prevention of water pollution, fishing conditions, construction in the border water body, etc. [76].

5.2.8. Agreement Concerning Frontier Watercourses between the Finnish Republic and the Soviet Union (1964)

The 1964 Agreement Concerning Frontier Watercourses between the Finnish Republic and the Soviet Union, signed at Helsinki on 24 April 1964 and put into force on 6 May 1965, seeks to "define the principles governing the use of the common frontier watercourses of Finland and the Soviet Union and to establish a regime for their use" and encompasses "lakes, rivers and streams which are intersected by the frontier line or along which the frontier line runs" [77]. In accordance with this agreement, the two states should refrain from undertaking activities "which might so alter the position, depth, level or free flow of watercourses in the territory of the other Contracting Party as to cause damage or harm to the water area, to fisheries, . . .which might create a danger of flooding, cause a significant loss of water; or which might in some other like manner be prejudicial to the public interest" [77].

5.2.9. Agreement between Finland and Sweden Concerning Transboundary Rivers (2009)

The 2009 Agreement between Finland and Sweden Concerning Transboundary Rivers, signed at Stockholm on 11 September 2009 and put into force on 1 October 2010, which replaces the 1971 Agreement between the two countries (the 1971 Agreement between Finland and Sweden Concerning Frontier Rivers) aims to enhance transboundary cooperation in water and ensure equal opportunities for the two countries to use transboundary rivers for the benefit of the frontier region [78]. While this agreement seeks to control flood and prevent environmental damages, it also reconciles the projects, programs, and actions in the water management area to achieve the objectives of sustainable use of waters [78], which is well in line with a nexus approach to WEF. In addition, this agreement grants extensive rights to the residents of the region to participate in the management of water permit issues on the other side of the border as well [78].

5.2.10. Agreement between Norway and the Union of Soviet Socialist Republics on the Utilization of Water Power on the Pasvik (Paatso) River (1957)

The Agreement between Norway and the Union of Soviet Socialist Republics on the Utilization of Water Power on the Pasvik (Paatso) River (with annexed charts), signed at Oslo on 18 December 1957 and put into force on 27 June 1958, has the objective of utilizing in a mutually beneficial and equitable fashion, the water power of the Pasvik River, located between the two countries [79]. This agreement facilitates the cooperation of the two countries in the area of the utilization of transboundary WEF resources as well as the prevention of environmental damage to the Pasvik River.

6. Conclusions

Our study suggested that international law provides the essential means to address a nexus approach to WEF and its pertinent issues and intricacies within a transboundary context. These means help enhance the regulation of WEF nexus in the Arctic from an international law standpoint. Within a region of transboundary nature, such as the Arctic, international cooperation is key to ensure equitable and sustainable governance of WEF resources. Such cooperation is particularly realized by engaging in joint efforts, including sharing data, information and knowledge, technology, capacity building, and financial assistance. It is worth noting that international legal arrangements, such as the UN Watercourses Convention, in which international cooperation among riparian states is a requisite, can be used to provide a basis for cooperation in the Arctic too. This convention emphasizes that riparian states shall cooperate on the basis of sovereign equality, territorial integrity, mutual benefit, and good faith to attain optimal utilization and adequate protection of an international watercourse [22].

The challenge with the traditional legal frameworks is that they often function within sectoral boundaries and may not adequately address the intricacies of the WEF nexus. Adopting integrated legal frameworks that explicitly recognize the interconnectedness and interdependencies of WEF systems can help address these intricacies. Such initiative may involve the harmonization of existing legal instruments and the development of new legal frameworks that promote cross-sectoral integration. Moreover, the Arctic region is experiencing rapid environmental changes, including climate change, which have implications for the WEF nexus. Promoting adaptive governance approaches that can respond to changing conditions and incorporate new knowledge is thus vital. This can involve flexible and iterative decision-making processes, monitoring and assessment mechanisms, and the ability to adjust policies and regulations based on new information and changing circumstances.

Recognizing and incorporating Indigenous rights and traditional knowledge into legal frameworks can contribute to more effective and sustainable regulation of the WEF nexus in the Arctic. This can involve ensuring meaningful participation of Indigenous communities in decision-making processes and respecting their rights to self-determination, lands, and resources. The human rights law provides a legal framework to ensure that the WEF

nexus is addressed in a manner that upholds human rights, particularly in regions such as the Arctic, where these rights may be at risk due to changing environmental conditions. International law equips states with the necessary legal means to engage in collaborative, sustainable, and rights-based approaches to WEF issues, making it well-suited to address the complexities and challenges of WEF systems in a transboundary context, such as the Arctic.

To sum up, addressing the international legal regime of the WEF nexus in the Arctic requires considering transboundary cooperation, equitable resource allocation, environmental protection, human rights, and climate change adaptation. It is through integrating these aspects that the legal framework can support a sustainable and secure approach to governing the WEF interdependencies in the Arctic. This research served as the first WEF nexus international law study in the Arctic. It was not intended to present a comprehensive analysis or a roadmap on how to address the complexities and challenges involved in the WEF nexus inclusively. Rather, as a starting point, it encouraged further research to identify other potentials relying on the fact that ample fertile grounds for future research exist in this discourse to discuss the granularities of the WEF nexus in the Arctic from an international law perspective, particularly international human rights law.

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